 ISSN:2449-075X

Wastewater Reuse: An Alternative for Sustainable Agriculture

Emenike PraiseGod Chidozie , Tenebe Imokhai Theophilus, Ben Ngene, Oniemayin Irewole Babatunde, Gideon Bamigboye, Ogundare Tosin, Busari Ayobami
Department of Civil Engineering
Covenant University
Ota, Nigeria
praisegod.emenike@covenantuniversity.edu.ng

***Abstract*— Africa is seen as one of the continent with the fastest population growth rate in the world. However, her landmass has seen 67% dryness, projecting that one of her problems could be water related. Similarly, maintaining agricultural produce seems to be the most exhaustive part of Africa's water with 85% being used for irrigation and agricultural activities. Target 2 of the Sustainable Development Goals (SDGs) is aimed at promoting sustainable agriculture, terminating hunger; achieving food security and improving the level of nutrition which makes Africa a probable zone. The study assessed different promotion practices in agricultural farmlands spread across Nigeria. In – depth interviews, farm investigations and group interactions amongst others were deployed in other to appraise farm size, water application frequency, and duration of application, water shortage experience, water usage and water saving measures. Quantitative data on water quantity used in farms were also captured. Results showed that water application within the farms relied on withdrawal from aquifers using tanker system. The shortage of water experienced within farms under study lasted for up to 3 hours. This will adversely pose underlying threats to the available water to be used for other purposes and also impede food production during water shortages. The study highlights that rain water harvesting (RWH) practices be carried out to reduce the pressure of agriculture on aquifer resources. The study proposed adequate management procedures that will help salvage the emanating challenges affecting food production.**

Keywords—SDG; rainwater harvesting; agriculture; food security

I. INTRODUCTION

One of the difficulties faced around the world is water scarcity [1-2]. Since the post – 2015, Sustainable Development Goal (SDG) made sustainable and economical access to water a priority while the need for effective management of water resource increases when the growing water need becomes paramount [3-4]. In an estimate given by UN, it is expected that 1.8million people will be living in regions categorized as "Water – Stressed" zone by 2025 with the population increase and climate change having its own part on the stress [5-6]. In addition, population increase is a continuous trend that demands increase in alternative water sources. The population increase and changing diets tends to mount serious pressure on existing fresh water sources thereby increasing the need to explore non – conventional water sources. On the other hand, climate change has its own contribution to water security by affecting the availability of renewable water sources in different regions [7-8].

The impact of climate change will culminate in harsh weather events and subsequent instability in crop output and local food production [9], particularly in the third – world countries [10]. In a report released by Food and Agriculture Organisation (FAO) [11], it is estimated that a reduction of 9 – 20% of the entire agricultural productivity will be lost to global warming and this indicates that climate change will inflict negative impact on agriculture and food security. In order to meet the demand of the growing population that will exceed 9billion in 2050, FAO estimated that an increase of 70% of the global food production must be met in the first halve of the century [11].

Presently in developing countries, the strategy employed to carry out water savings focuses on evaluating the extent of water withdrawals thereby underestimating the full potential of wastewater reuse. Reference [12] made a remark that withdrawal of fresh water can be reduced when wastewater is reused since 80% of exhausted water is transformed to wastewater. Furthermore, [13] itemized that 30 – 50% of household water could be recovered when adequate treatment is administered. Reference [14] supported the statement, stating that treated municipal wastewater can be reused to propagate urban agriculture.

Three categories of wastewater reuse have been stated by the United States – Environmental Protection Agency; (i) Direct Use, in which the influent is a product of the effluent (With or without treatment); (ii) Planned indirect Use, where a return environment is constructed to receive the wastewater before it is collected for reuse (e.g. wetland); (iii) Unplanned indirect use, in which the wastewater receiving platform is a natural environment (rivers/lakes) with the collection source serving as a fresh source for other intended use in downstream location [15-16]. The unplanned indirect water reuse happens in all waterways, yet there is little report of its exploitation [17] despite the potentials and benefits of treated and reused water [18].

The overall motive of this research is to provide accurate assessment of water flow data from withdrawals as well as appraising the available methods for water collection and treatment which can be used for agriculture within some

 ISSN:2449-075X

selected farms in Nigeria. This will help in reducing over – exploitation of groundwater resources.

II. METHOD OF DATA COLLECTION

Assessment of farmlands was carried out at random. The farmlands studied were located in the South – east and South – west zones of Nigeria. Quantitative data was collected in order to appraise the dependence on withdrawals to satisfy farm production needs. The farms considered includes; Ekwuribe livestock farm (located at Ajah, Lagos State), Ogundeji farm (located in Akure, Ondo State), Chekwube livestock farm (located in Enugu State), Ojemaie livestock farm (located in Port – Harcourt) and two Covenant University (CU) farm (located in Ota and Igbesa, Ogun State). The information gathered captured the farm size, water application frequency, duration of application, experiences relating to water shortages, water usage and available water saving measures. Physical observation and personal Interviews were also adopted.

III. RESULTS AND DISCUSSION

A. Farm Size

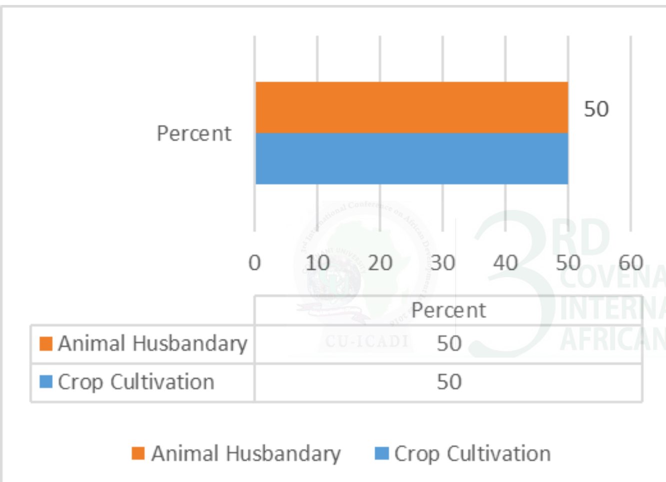

Fig 1: Percentage of Farm Activities

According to the findings (Fig 1), 50% of the farms assessed practice animal husbandry while 50% cultivate crops. The size of land used for farms that practice animal husbandry is 3 Acre, ½ Acre and 2 Acre for Ekweribe, Chekwube and Ojemaie livestock farms respectively and all the farms are located in south – eastern zone of Nigeria. Ogundeji farm and CU farms (Igbesa and Ota) had more than 3 Acres each used to cultivate arable crops. The size of agricultural area assessed in this study is a vital requirement because its operational capability depends on the amount of water required for its activities [19].

B. Water Application

Chekwube farm, CU farm (Igbesa) and Ojemaie Farm had one borehole each located within the farm premises while CU farm (Ota) had 2 boreholes. The volume of water utilized within the agricultural area are 2000litres, 1000litres and 500litres per day for Chekwube farm, CU farm (Igbesa) and Ojemaie farm respectively. The farmlands enjoyed unimpeded access to water, using the tanker system for distribution (Fig 2). Reports showed that two – third of water used for farm activities were collected from groundwater resource while one – third were gotten from alternative sources such as streams, rivers, ponds and rainwater. The farms assessed made use of drip/localized system as the water application mechanism. On the long run, taking CU farm as a case study, about 60,000liters of water will be required majorly in dry seasons which may be prolonged as a result of climate change effect. However, this is not a sustainable approach as population within the community will surely increase. This increase is early anticipated as post graduate students are on board now and a new Faith theatre building with covenant estate is to be built in no time. The water required to cater for this population is quite high and complete dependence on ground water is a big risk. However, to cushion this effect, RWH could be used to supplement water redrawn for irrigation agriculture and proper personal water management practice.

Fig. 2 showing the extraction of groundwater for agricultural applications

C. Water application duration/frequency

Findings showed that the efficiency of water supply service is high in all farms visited indicating that there is a continuous withdrawal from the underground resource available. Withdrawal is unimpeded and the withdrawal rate could last up to 3 hours per day, reason being that the source is easily accessible found at the point of use. These actions support wastage and depletion of the groundwater resource available. The adverse effect of wastage and depletion could lead to shortage which affects economic growth and food security in the long run.

ISSN:2449-075X

D. Experiences and Water saving measures

Documented experiences within the farm showed that 25% of the farms assessed encountered water shortages for several hours while 50% of the farm operators mentioned that shortages have lasted up to several days. The remaining 25% explained that other measures are taken to avert water shortages within the farms. Even though water saving measures were not practiced in full, 50% of the farm operators encouraged the method, adopting rainwater harvesting as the option. Farm practitioners go as far as getting water from other sources that depend on groundwater resources when shortages are experienced. These water collection systems to satisfy farm needs are transported through tankers to farmlands where they are utilized. While some farmers practice rainwater harvesting in a small scale, the rainwater collected served several purposes; 33.33% of the operators use it for domestic purposes while 66.67% apply it on crops.

Reliability studies was conducted to evaluate the current water supply within the farms. The results obtained is represented in Table 1. Below. The data captured conditions that relates to the aspects of water supply that needs improvement in future and timely maintenance carried out when needed. The consideration requirement for future improvement outlined in the study were rated in three categories namely; Borehole Reliability, Routine Maintenance and Source of water supply.

TABLE 1: CROSSTABULATION OF RELIABILITY STUDIES

		Which of The Following Aspects of Your Water Supply Do You Need Improvement In The Future?			
		R(%)	*M(%)*	*SS(%)*	*Total (%)*
How is the current Water Supply Service?	Excellent	0	0	16.67	16.67
	Very Good	33.33	16.67	16.67	66.67
	Good	0	0	16.67	16.67

		Do You Have A Timely Maintenance Whenever it is Needed?		
		Yes(%)	*No(%)*	*Total (%)*
How is the current Water Supply Service?	Excellent	16.67	0	16.67
	Very Good	50.00	0	50.00
	Good	0	33.33	33.33

[Keys: R (Reliability), M (Maintenance), SS (Source of Supply)]

From Table 1. displayed above, Farmers clamor for improvement in their water facility constructed within the farms in order to boost production. 50% call for source improvement which stands as a pointer that water sources required for farming activities is limited. 16.67% want maintenance while 33.33% are of the opinion that the water available is not reliable. The obvious fact was stated when the farm operator in one of the location (Ogundeji Farm) explained that water scarcity occurs during the hours of 11am and 2pm daily. This timely scarcity has halted farm operations as well as food production.

For food production to correlate with water supply, adequate and timely maintenance of the water distribution system is required. The general inference obtain from the results espouses the fact that maintenance factor leaves a question mark within farmlands since no maintenance is carried out in 33.33% of the farms. With the rate at which climate change affects the environment, there is no doubt that it will take its toll on food production since increasing temperature within the environment gives rise to increase in evaporation of water molecules required for plant growth.

IV. CONCLUSION

This study has assessed the utilization of underground resources for irrigation agriculture in some selected farms in Nigeria. From this study, it is evidence that overburden of underground water is practiced in all the farms which makes both irrigation and food production not sustainable. With the challenge of global climate change and world increasing population, this is a major concern. Similarly, if this concern is not taking care of, it may result in over-dependence on food produced only during dry season as it may not require much watering. However, with our major study on CU farm, it is important to elaborate on the growing population which was about 10000 residents in 2013 [20]. The wastewater generated within the community amounts up to 1,000,000 litres daily. This could serve as a potential resource when harvested, treated and used for agricultural applications within the CU farm. This treatment, especially the grey water could be very useful as little treatment is required. From Figure. 3 below, the water used for watering of flowers were collected from the underground resource.

Fig. 2 showing water application on flowers

Treated water could be channeled to the watering of flowers thereby reducing the total reliance on groundwater. Adopting this mechanism will set the pace for farmers in the Sub – Saharan region which will in turn promote food production and also mitigate the impact of adverse climate change within the region. Also, personal discipline should be imbibed on the use of water resources, for it was noticed that when water is not readily available, the wastewater available (when treated) will be sufficient enough when properly managed during irrigation.

Of a truth, sustainable agriculture requires substantial investment for agricultural development to improve but water conservation structures seem to be key to restoring the natural capacity of our depleting water resources.

REFERENCES

[1] Fao. Coping with water scarcity: An action framework for griculture and food security. Food and Agricultural Organization of the United Nations, Rome, Italy, 2012.

[2] UN-Water. The United Nations World Water Development Report 4: Managing water under uncertainty and risk. World Water Assessment Programme (WWAP), Paris, France, 2012.

[3] Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M. C., Shyamsundar, P., Noble, I.. Policy: Sustainable Development Goals for people and planet. Nature 2013, 495(7441), 305-307.

[4] UN-Water. Water Security & the Global Water Agenda: A UN-Water Analytical Brief, 2013.

[5] Emenike, P., Tenebe, I., Omole, D., Julius Ndambuki, J., Ogbiye, A and Sojobic, A. *Application of water recovery option for agricultural use in developing countries: Case study of a Nigerian community*. Conference on International Research on Food Security, Natural Resource Management and Rural Development. Tropentag 2015, Berlin, Germany. September 16-18.

[6] UN Water. Coping with water scarcity: Challenge of the twenty-First century. 2007 World Water Day (http://www.fao.org/nr/water/docs/escarcity.pdf. Accessed 17 March 2016).

[7] Falkenmark, M. Growing water scarcity in agriculture: Future challenge to global water security. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 2013, 371(2002): 20120410-20120410.

[8] Oki, T., Kanae, S.,. Global Hydrological Cycles and World Water Resources. Science 2006, 313(5790): 1068–1072.

[9] IPCC (Intergovernmental Panel on Climate Change). Managing the risks of extreme events and disasters to advance climate change adaptation. Special report. Cambridge University Press, Cambridge 2012.

[10] Wang, J., Huang, J., & Yan, T.. Impacts of Climate Change on Water and Agricultural Production in Ten Large River Basins In China. Journal of Integrative Agriculture 2013, 12(7): 1267-1278.

[11] FAO (Food and Agriculture Organization). How to feed the world in 2050. FAO, Rome, 2009.

[12] Omole, D.O. and Isiorho, S.A. Waste management and water quality issues in coastal states of Nigeria: The Ogun State experience. Journal of Sustainable Development in Africa 2011, 13(6):207-217.

[13] Uddin et al. Opportunities and Challenges for Greywater Treatment and Reuse in Mongolia: Lessons learnt from piloted systems. Journal of Water Reuse and Desalination 2014, 4(3): 182.

[14] Woltersdorf, L., Liehr, S., Scheidegger, R., & Döll, P. Small-scale water reuse for urban agriculture in Namibia: Modeling water flows and productivity. Urban Water Journal 2014, 12(8): 691-691.

[15] U.S. Environmental Protection Agency. Guidelines for water reuse (EPA/600/R-12/618 Washington D.C.) 2012a.

[16] Asano, T., Burton, F., Leverenz, H., Tsuchihashi, R., Tchobanoglous, G.. Water reuse: Issues, technologies and applications, 2007.

[17] De Vries, G. E., & Lopez, A. Wastewaters are not wastes. Living with water 2012, 101-141.

[18] Drechsel, P., Mara, D. D., Bartone, C., & Scheierling, S. M. Improving wastewater use in agriculture: An emerging priority. Policy Research Working Papers 2010.

[19] Woltersdorf, L., Scheidegger, R., Liehr, S., & Döll, P. Municipal water reuse for urban agriculture in namibia: Modeling nutrient and salt flows as impacted by sanitation user behavior. Journal of Environmental Management 2016, 169: 272-284

[20] Isiorho, S. A., Omole, D. O., Ogbiye, S. A., Olukanni, D. O., Ede, A. N., & Akinwumi, I. I. Study of reed-bed of an urban wastewater in a Nigerian community. Computers and Advanced Technology in Education / 820: Modelling, Simulation and Identification / 821: Environmental Management and Engineering 2014.

